MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

DET5028 – INDUSTRIAL ELECTRONICS

(Diploma in Electronic Engineering - All sections/groups)

8 OCTOBER 2016

2:30 PM – 4:30 PM

(2 HOURS)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **6** pages with **5** questions.
2. Answer **ALL** questions. All necessary working steps **MUST** be shown.
3. Write all your answers in the answer booklet provided.

QUESTION 1 [20 marks]

(a) Draw a PLC ladder diagram to realize the following functions:

(i) E = (A OR C) AND ((NOT B) OR D)

[5 marks]

(ii) Z = ((NOT V) AND W) OR (X AND Y)

[5 marks]

(b) Develop a PLC program that will latch on an output (B), 20 seconds after input (A) has been turned on. After the 3rd time the timer had been timed to 20 seconds, B will be unlatched. The process will always loop through the same sequence until A is turned off. The timer and counter will self-reset every time.

The answer should be drawn into a single ladder diagram only.

[10 marks]

Continued ...

QUESTION 2 [20 marks]

(a) Briefly explain the electromechanical relay as shown in *Figure 2-1* and its operating principle.

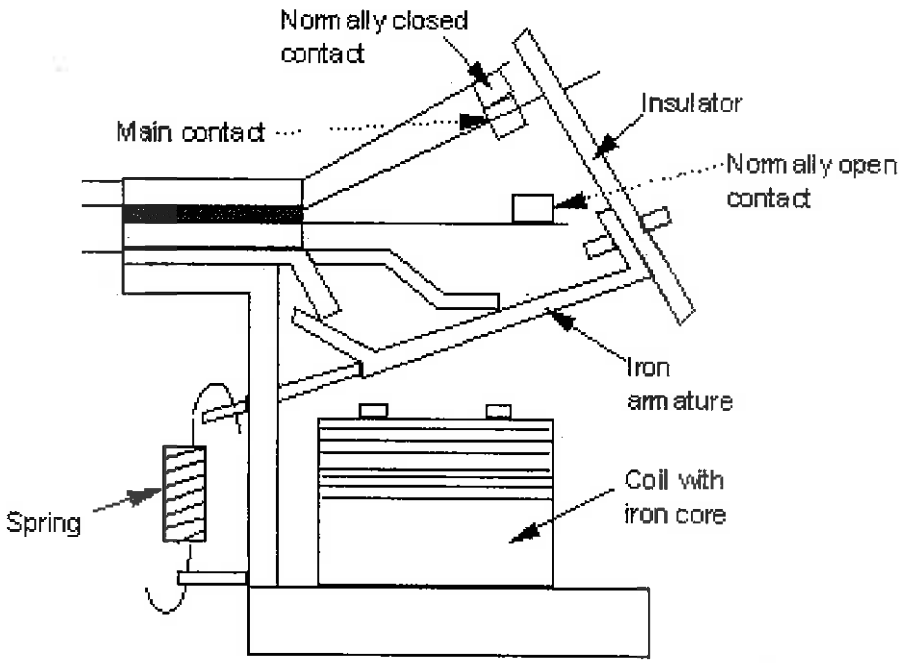

Figure 2-1

[6 marks]

Continued ...

(b) Refer to the relaxation oscillator circuit as shown in *Figure 2-2*. Given that:

$V_{DC} = 25\,\text{V}$, $R = 8\,\text{k}\Omega$, $R_2 = 350\,\Omega$, $C = 0.25\,\mu\text{F}$, $r_{BB} = 12\,\text{k}\Omega$, $r_{B1} = 7\,\text{k}\Omega$, $V_{EB1(sat)} = 1.8\,\text{V}$, $I_V = 5\,\text{mA}$ and $I_p = 6\,\mu\text{A}$. When the UJT is in conduction, $r_{B1} = 25\,\Omega$.

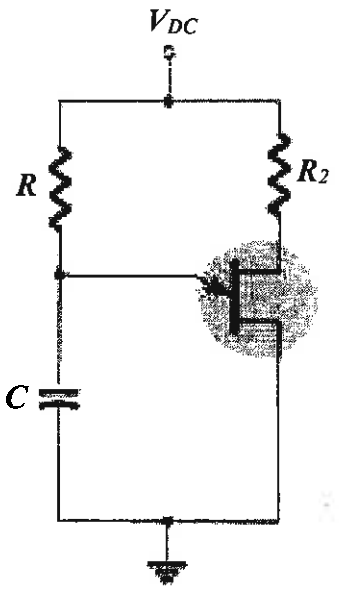

Figure 2-2

Determine:

(i) The charging time and discharging time.

[10 marks]

(ii) The maximum and minimum values of R that could be used in the circuit.

[4 marks]

Continued ...

QUESTION 3 [20 marks]

(a) An RTD with $R_{T_0} = 750\,\Omega$ is placed in a circuit with a voltage of 6 V across it at 50 °C, where:

- The resistance of the sensor at 10 °C is 100 Ω.
- The self-heating factor is $F_{SH} = 0.01\,°C/mW$.
- The temperature coefficient of resistivity is $\alpha = 0.003902/°C$.

(i) Determine the error that occurred due to the self-heating of the RTD.

[8 marks]

(ii) Find the new resistance value of the RTD due to its self-heating problem.

[4 marks]

(b) An indicator wire in a strain gauge has a gauge factor of 3.2, where:

- The wire's initial length was 35 mm.
- The wire's original resistance was 125 Ω.
- The wire's strain is $\varepsilon = 245\ \mu$.

(i) Determine the final length of the wire after it is strained.

[4 marks]

(ii) Find the final (strained) resistance of the wire.

[4 marks]

Continued ...

QUESTION 4 [20 marks]

(a) An optocoupler is essentially an interface between two circuits which operate at usually different voltage levels. State 4 reasons for using an opto-coupler for such purpose.

[4 marks]

(b) An optical position-encoder has a 15:5 gear ratio and an optical disc with 60 slits. It also has a direction-indicating ability. Its output is a 9-bit signed magnitude binary, with the 9^{th} bit on the far left representing either sign bit 0 for positive (disc rotating clockwise), or 1 for negative (disc rotating counter clockwise).

(i) What is the resolution of this transducer?

[2 marks]

(ii) What is the maximum allowable shaft motion to ensure that the counter never exceed its capacity?

[4 marks]

(iii) What direction and amount of shaft movement represented by a binary output of 0 1111 1100?

[4 marks]

(iv) If the measured shaft moves 4/3 turn in counter clockwise rotation, what is the content of the binary counter?

[3 marks]

(v) If the measured shaft moves 376° in clockwise rotation, what is the content of the binary counter?

[3 marks]

Continued ...

QUESTION 5 [20 marks]

(a) A compound DC motor has both a series and shunt field. The series field is connected in series with the armature circuit, while the shunt field is connected in parallel with the armature field. Describe briefly the performance characteristics of the compound DC motor.

[4 marks]

(b) A shunt-configured DC motor is designed to have an armature winding resistance $R_A = 2\,\Omega$, an applied voltage $V_A = 200\,\text{V}$, a field winding resistance $R_F = 200\,\Omega$, an armature current $I_A = 1.5\,\text{A}$, a proportionality constant $k_{E_C} = 0.06982$, a magnetic field strength $B = 0.95\,\text{T}$ and $k_t = 0.83$.

(i) Find the motor's proportionality factor $k_{E_{C3}}$.

[8 marks]

(ii) Calculate the motor's output torque τ and its mechanical power P_{mech}.

[6 marks]

(iii) Suppose that when the field current is increased to $I_F = 1.43\,\text{A}$, the speed will slow to S = 2840 r/min. Find the motor's new value of CEMF.

[2 marks]

End of Page.